Small Business Innovation Research/Small Business Tech Transfer

INVESTIGATION OF NON ERODING NOZZLE MATERIALS FOR OPTIMIZED COATED HYBRID LEADING EDGE DESIGNS FOR REUSABLE LAUNCH VEHICALS WITH LEADING EDGE RADII OF 0.03? TO 1? AND TEMPERATURES NEAR 4000?F, Phase I

Completed Technology Project (2004 - 2004)

Project Introduction

Effort explores using innovative hybrid reinforced carbon-carbon, refractory ceramics, super alloys and composite materials as thermal protection system specifically in the 4000?F range with leading edge radii of between 0.03? and 1.0?. The RLV leading edge is the primary TPS that space vehicles use re-entering the atmosphere traveling at hypersonic speeds. Depending on the Mach number spacecraft surface temperatures are as high 4000?F. The shape of the RLV leading edge, primarily the radius affects the functionality of the spacecraft including RLV drag, lift and leading edge aero-thermal heating. Sharper leading edges create lift and re-entry cross range capabilities. The downside of sharp leading edges is that aero-thermal heating is increased, resulting in steep thermal gradients. These thermal gradients create high thermal stresses. Blunt leading edges leading edges have less thermal gradient and therefore thermal stresses are lower. However, the cross range capabilities of the vehicle are reduced. Tasks include parametric definition of hybrid composite material architectures RLV leading edge for maximum lift, cross range and durability at temperatures of 4000?F for radii in the 0.03 to 1? range. The goal is finding the optimal hybrid composite material combinations/coatings and architectures for given leading edge radii. RLV. Analyses for hybrid leading edge designs include: Micro-mechanical material computations for hybrid material property, calculation of leading edge aerothermal heating heat transfer coefficient, heat rate and pressure load as a function of leading edge radius. Transient heat transfer analyses for calculation of leading edge thermal gradients. Thermal stress analyses using temperature gradients. Evaluation of leading edge response, as a function of hybrid material architecture via material failure ratios. The result of these analyses will provide the best hybrid material candidates and RLV leading edge designs.

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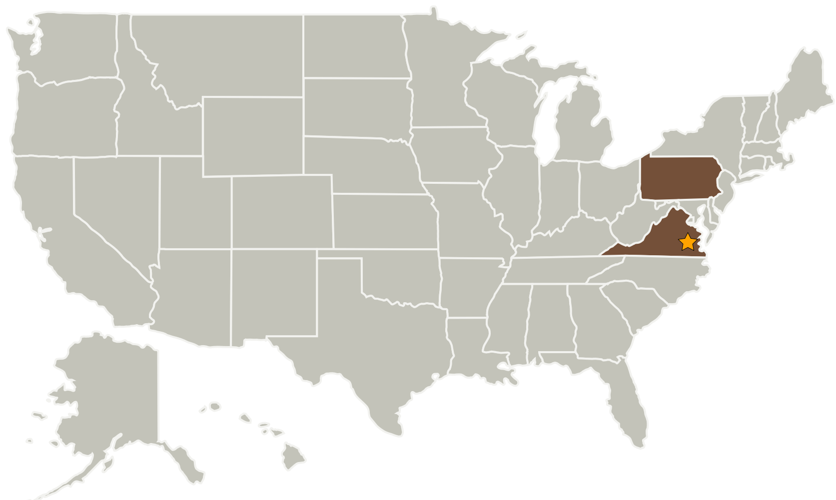
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
Materials Research and Design, Inc.	Supporting Organization	Industry	Wayne, Pennsylvania

Primary U.S. Work Locations	
Pennsylvania	Virginia

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Guido Teti

Technology Areas

Primary:

- TX02 Flight Computing and Avionics
  - └ TX02.2 Avionics Systems and Subsystems
    - └ TX02.2.9 Hardware Enabling Secure Avionics